**WHAT IS CLAIMED IS:**

1. A control apparatus for controlling an intake air quantity to the engine by varying an intake valve closing timing of the engine, the control apparatus comprising:

a controller configured

to calculate a target air quantity in accordance with an engine operating state,

to calculate an estimated internal EGR quantity of the engine in accordance with the engine operating state,

to calculate a target intake valve closing timing in accordance with the target air quantity and the estimated internal EGR quantity, and

to control an actual intake air quantity to the engine by controlling an actual intake valve closing timing of the engine to achieve the target intake valve closing timing.

2. The control apparatus as claimed in Claim 1, wherein the controller is configured to calculate the estimated internal EGR quantity in accordance with a target exhaust valve closing timing for the engine and an engine speed of the engine.

3. The control apparatus as claimed in Claim 2, wherein the controller is configured to calculate a base internal EGR quantity in accordance with the target exhaust valve closing timing and the engine speed, and to determine the estimated internal EGR quantity by modifying the base internal EGR quantity with an overlap correction quantity determined in accordance with a valve overlap condition of the engine.

4. The control apparatus as claimed in Claim 3, wherein the controller is configured to determine a valve overlap quantity in accordance with an interval between a target

intake valve opening timing and the target exhaust valve closing timing, and to determine the estimated internal EGR quantity by addition of the overlap correction quantity to the base internal EGR quantity.

5. The control apparatus as claimed in Claim 4, wherein the controller is configured to increase the base internal EGR quantity with increase in an interval from one of an exhaust top dead center and the target exhaust valve closing timing to the other.

6. The control apparatus as claimed in Claim 4, wherein the controller is configured to increase the base internal EGR quantity as the engine speed increases when the target exhaust valve closing timing is before an exhaust top dead center.

7. The control apparatus as claimed in Claim 4, wherein the controller is configured to decrease the base internal EGR quantity as the engine speed increases when the target exhaust valve closing timing is after an exhaust top dead center.

8. The control apparatus as claimed in Claim 4, wherein the controller is configured to increase the estimated internal EGR quantity by increasing the overlap correction quantity with increase in the valve overlap quantity representing a valve overlap period.

9. The control apparatus as claimed in Claim 4, wherein the controller is configured to calculate the estimated internal EGR quantity by decreasing the overlap correction quantity with increase in a retard of the target exhaust valve closing timing from an exhaust top dead center when

the target exhaust valve closing timing is after the exhaust top dead center.

10. The control apparatus as claimed in Claim 8, wherein the controller is configured to increase the estimated internal EGR quantity by increasing the overlap correction quantity with increase in an absolute value of an intake pressure on a negative pressure side.

11. The control apparatus as claimed in Claim 8, wherein the controller is configured to calculate the overlap correction quantity by modifying a base correction quantity determined by the valve overlap quantity, with an intake pressure modification quantity determined in accordance with an intake pressure and the target exhaust valve closing timing.

12. The control apparatus as claimed in Claim 11, wherein the controller is configured to determine the valve overlap quantity by converting a valve overlap angular interval expressed as an angular distance in crankshaft rotation to a valve overlap time period.

13. The control apparatus as claimed in Claim 11, wherein the controller is configured to determine an intermediate quantity in accordance with the valve overlap quantity, to set the base correction quantity equal to the intermediate quantity when the target exhaust valve closing timing is before an exhaust top dead center, and to determine the base correction quantity by subtraction from the intermediate quantity, of a subtrahend proportional to a retard quantity of the exhaust valve closing timing with respect to the exhaust top dead center when the target exhaust valve closing timing is after the exhaust top dead center.

14. The control apparatus as claimed in Claim 11, wherein the controller is configured to determine a modification coefficient, as the modification quantity, in accordance with the intake pressure, the target exhaust valve closing timing and the valve overlap quantity; and wherein the controller is configured to calculate the overlap correction quantity by multiplying the base correction quantity by the modification coefficient.

15. The control apparatus as claimed in Claim 11, wherein the controller is configured to increase the modification quantity as an absolute value of the intake pressure increases on a negative side, and to increase the modification quantity in accordance with a retard quantity of the exhaust valve closing timing from an exhaust top dead center when the exhaust valve closing timing is after the exhaust top dead center and the absolute value of the intake pressure is higher than a predetermined level.

16. The control apparatus as claimed in Claim 4, wherein the controller is programmed to determine the estimated internal EGR quantity by addition, to the base internal EGR quantity, of an overlap increase correction quantity which is increased as the valve overlap quantity increases; and wherein the controller is programmed to modify the base internal EGR quantity with the overlap increase correction quantity when the target exhaust valve closing timing is after the target intake valve opening timing, and to set the estimated internal EGR quantity equal to the base internal EGR quantity when the target exhaust valve closing timing is not after the target intake valve opening timing.

17. The control apparatus as claimed in Claim 16, wherein the controller is programmed to increase the base internal

EGR quantity with increase in an advance of the exhaust valve closing timing from the exhaust top dead center when the exhaust valve closing timing is before the exhaust top dead center, and to increase the base internal EGR quantity with increase in a retard of the exhaust valve closing timing from the exhaust top dead center when the exhaust valve closing timing is after the exhaust top dead center; and wherein the controller is programmed to determine the overlap increase correction quantity in accordance with the valve overlap quantity, the target exhaust valve closing timing and an intake pressure controlled by a throttle valve.

18. The control apparatus as claimed in Claim 1, wherein the control apparatus further comprises a variable valve timing actuator comprising a solenoid to vary the actual intake valve closing timing in response to an electric control signal produced by the controller, and a sensor system to sense engine operating conditions to determine the engine operating state.

19. A method for an engine, the method comprising:

obtaining information on an exhaust valve closing timing, an intake valve opening timing and an engine speed; and

calculating an estimated internal EGR quantity of the engine in accordance with the exhaust valve closing timing, the intake valve opening timing and the engine speed.

20. The method as claimed in Claim 19, wherein, as the exhaust valve closing timing, a target exhaust valve closing timing is used for calculating the estimated internal EGR quantity.

21. The method as claimed in Claim 19, wherein the method is an internal EGR quantity estimating method; and

wherein the method further comprises calculating a base internal EGR quantity in accordance with the exhaust valve closing timing and the engine speed; and the estimated internal EGR quantity is set equal to the base internal EGR quantity without modification when there is no valve overlap between an exhaust valve opening period and an intake valve opening period, and the estimated internal EGR quantity is determined by modifying the base internal EGR quantity with a valve overlap condition of the engine when there is a valve overlap.

22. The method as claimed in Claim 21, wherein the method further comprises calculating an overlap correction quantity in accordance with the overlap condition; and the estimated internal EGR quantity is determined by addition of the overlap correction quantity to the base internal EGR quantity when there is a valve overlap between the exhaust valve opening period and the intake valve opening period.

23. The method as claimed in Claim 21, wherein the base internal EGR quantity is increased with increase in an interval from one of an exhaust top dead center and the exhaust valve closing timing to the other.

24. The method as claimed in Claim 21, wherein the base internal EGR quantity is increased as the engine speed increases when the exhaust valve closing timing is before an exhaust top dead center.

25. The method as claimed in Claim 21, wherein the base internal EGR quantity is decreased as the engine speed increases when the exhaust valve closing timing is after an exhaust top dead center.

26. The method as claimed in Claim 22, wherein the estimated internal EGR quantity is increased by increasing the overlap correction quantity with increase in a valve overlap quantity between the exhaust valve opening period and the intake valve opening period.

27. The method as claimed in Claim 22, wherein the estimated internal EGR quantity is decreased by decreasing the overlap correction quantity with increase in a retard of the exhaust valve closing timing from an exhaust top dead center when the exhaust valve closing timing is after the exhaust top dead center.

28. The method as claimed in Claim 26, wherein the estimated internal EGR quantity is increased by increasing the overlap correction quantity with increase in an absolute value of an intake pressure on a negative pressure side.

29. The method as claimed in Claim 22, wherein the method further comprises calculating a base correction quantity in accordance with a valve overlap quantity; and calculating an intake pressure modification quantity in accordance with an intake pressure and the exhaust valve closing timing; and the overlap correction quantity is determined by modifying the base correction quantity with the intake pressure modification quantity.

30. The method as claimed in Claim 26, wherein the valve overlap quantity is determined by converting a valve overlap angular interval expressed as an angular distance in crankshaft rotation to a valve overlap time period.

31. The method as claimed in Claim 29, wherein the method further comprises determining an intermediate

quantity in accordance with the valve overlap quantity; setting the base correction quantity equal to the intermediate quantity when the exhaust valve closing timing is before an exhaust top dead center; and determining the base correction quantity by subtraction from the intermediate quantity, of a subtrahend proportional to a retard quantity of the exhaust valve closing timing with respect to the exhaust top dead center when the exhaust valve closing timing is after the exhaust top dead center.

32. The method as claimed in Claim 29, wherein an intake pressure modification coefficient is determined, as the intake pressure modification quantity, in accordance with the intake pressure, the exhaust valve closing timing and the valve overlap quantity; and wherein the overlap correction quantity is calculated by multiplying the base correction quantity by the intake pressure modification coefficient.

33. The method as claimed in Claim 29, wherein the intake pressure modification quantity is increased as an absolute value of the intake pressure increases on a negative side, and the intake pressure modification quantity is increased in accordance with a retard quantity of the exhaust valve closing timing from an exhaust top dead center when the exhaust valve closing timing is after the exhaust top dead center and the absolute value of the intake pressure is higher than a predetermined level.

34. The method as claimed in Claim 19 wherein the method is an engine cylinder intake air quantity calculating method, and the method further comprises:

calculating an engine cylinder intake air quantity in accordance with the estimated internal EGR quantity.

35. The method as claimed in Claim 34, wherein the method further comprises calculating a cylinder air volume quantity in accordance with the estimated internal EGR quantity and a cylinder volume calculated from the intake valve closing timing; the engine cylinder intake air quantity is an engine cylinder intake air mass quantity which is the mass of air inducted into a cylinder section of the engine; and the engine cylinder intake air mass quantity is calculated in accordance with the cylinder air volume quantity, an intake manifold air mass quantity and an intake manifold volume.

36. The method as claimed in Claim 35, further comprising calculating the intake manifold air mass quantity by calculating a balance between an intake manifold inflow air mass quantity which is the mass of air flowing into an intake manifold section of the engine, and an intake manifold outflow air mass quantity which is the mass of air flowing out of the intake manifold section.

37. The method as claimed in Claim 19, wherein the method is an engine control method, and the method further comprises:

controlling the engine in accordance with the estimated internal EGR quantity.

38. The method as claimed in Claim 37, wherein the method is an engine ignition timing control method, and ignition timing of the engine is controlled in accordance with the estimated internal EGR quantity.

39. The method as claimed in claim 38, further comprising:

calculating a residual gas ratio in accordance with the estimated internal EGR quantity, the residual gas ratio being a mass ratio of a residual gas quantity to a total cylinder gas quantity;

calculating a combustion speed in accordance with the residual gas ratio;

calculating a combustion reaction time from a start of ignition to a peak of a combustion pressure, in accordance with the combustion speed; and

calculating a maximum torque producing ignition timing in accordance with the combustion reaction time, to control an actual ignition timing of the engine to achieve the maximum torque producing ignition timing.

40. The method as claimed in Claim 37, wherein the method is an engine valve timing control method, and an intake valve closing timing of the engine is controlled in accordance with the estimated internal EGR quantity.

41. The method as claimed in Claim 40, wherein the intake valve closing timing is controlled in accordance with the estimated internal EGR quantity and a target intake air quantity calculated in accordance with an engine operating state.

42. An apparatus comprising:

an internal EGR quantity estimating section to calculate an estimated internal EGR quantity of an engine in accordance with an exhaust valve closing timing, an intake valve opening timing and an engine speed of the engine.

43. The apparatus as claimed in Claim 42, wherein the apparatus is an engine cylinder intake air quantity estimating apparatus; and the apparatus further comprises:

an engine cylinder intake air quantity estimating section to calculate an engine cylinder intake air quantity in accordance with the estimated internal EGR quantity.

44. The apparatus as claimed in Claim 42, wherein the apparatus is an engine control apparatus; and the apparatus further comprises:

a controlling section to control the engine in accordance with the estimated internal EGR quantity.

45. The apparatus as claimed in Claim 44, wherein the controlling section is configured to control an ignition timing of the engine in accordance with the estimated internal EGR quantity.

46. The apparatus as claimed in Claim 44, wherein the controlling section is configured to control an intake valve closing timing of the engine in accordance with the estimated internal EGR quantity.

47. The apparatus as claimed in Claim 46, wherein the apparatus further comprises a target air quantity calculating section to calculate a target air quantity in accordance with an engine operating state, and the controlling section is configured to control the intake valve closing timing in accordance with the target air quantity and the estimated internal EGR quantity.

48. An apparatus for an engine, the apparatus comprising:

means for collecting information on an exhaust valve closing timing, an intake valve opening timing and an engine speed of the engine; and

means for calculating an estimated internal EGR quantity of the engine in accordance with the exhaust valve closing timing, the intake valve opening timing and the engine speed.

49. The apparatus as claimed in Claim 48, further comprising means for controlling an engine operating parameter of the engine in accordance with the estimated internal EGR quantity.